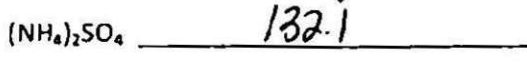
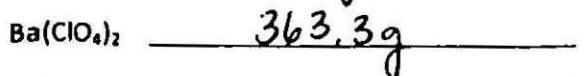
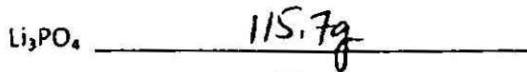
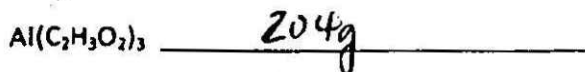


Using the mole map in your chapter 11 Packet, complete the following calculations

**Molar Mass.** Remember that the molar mass is calculated by summing the products of the number of each atom by their mass (from the periodic table).

Example: Mass of one mole of  $\text{Cu}(\text{OH})_2 = 1(\text{Cu}) + 2(\text{O}) + 2(\text{H}) = 1(63.5\text{g}) + 2(16.0\text{g}) + 2(1.0\text{g}) = 97.5\text{g}$



**Particle to Mole conversions.** ( $1\text{mole} = 6.02 \times 10^{23}$ )

How many water molecules are there in 14.8 moles of water?

$$14.8 \text{ moles } \text{H}_2\text{O} \left( \frac{6.02 \times 10^{23}}{1 \text{ mole}} \right) = 8.91 \times 10^{24} \text{ molecules } \text{H}_2\text{O}$$

How many moles are represented by  $1.4 \times 10^{13}$  formula units of  $\text{NaCl}$ ?

$$1.4 \times 10^{13} \text{ fu NaCl} \left( \frac{1 \text{ mole}}{6.02 \times 10^{23}} \right) = 2.3 \times 10^{-11} \text{ fu NaCl}$$

**Mass to Mole Problems** ( $1\text{mole} = \text{the molar mass of a substance}$ ) Hint: you have already calculated some molar masses above that you may use to do these problems.

What is the mass of 2.6 moles of barium <sup>per</sup>chlorate? ( $\text{Ba}(\text{ClO}_4)_2$  from above)

$$2.6 \text{ mole } \text{Ba}(\text{ClO}_4)_2 \left( \frac{363.3\text{g}}{1 \text{ mole}} \right) = 945 \xrightarrow{2\text{sf}} 950 \text{ g } \text{Ba}(\text{ClO}_4)_2$$

How many moles of ammonium sulfate are in 183g of ammonium sulfate?

$$183 \text{ g } (\text{NH}_4)_2\text{SO}_4 \left( \frac{1 \text{ mole}}{132.1} \right) = 1.39 \text{ moles } (\text{NH}_4)_2\text{SO}_4$$

**Volume to Mole Problems** ( $1\text{mole of a gas at STP} = 22.4\text{L}$ )

What is the volume of 0.78 moles of hydrogen gas at STP?

$$0.78 \text{ mol } \text{H}_2 \left( \frac{22.4\text{L}}{1 \text{ mol}} \right) = 17 \text{ L } \text{H}_2$$

How many moles of gas are in 17.6L of chlorine gas at STP?

$$17.6 \text{ L } \text{Cl}_2 \left( \frac{1 \text{ mol}}{22.4\text{L}} \right) = 0.786 \text{ mol } \text{Cl}_2$$

## Conversions

1. How many formula units of
- $\text{BaCl}_2$
- are there in 1.58 moles of
- $\text{BaCl}_2$
- ?

$$1.58 \text{ moles } \text{BaCl}_2 \left( \frac{6.02 \times 10^{23} \text{ fu}}{1 \text{ mole}} \right) = 9.51 \times 10^{23} \text{ fu of } \text{BaCl}_2$$

2. Which has more atoms, 10 g of carbon or 10 g of calcium?

10g Carbon

$$10 \text{ g C} \left( \frac{1 \text{ mole}}{12 \text{ g}} \right) = 0.8 \text{ mole C}$$

$$10 \text{ g Ca} \left( \frac{1 \text{ mole}}{40 \text{ g}} \right) = 0.2 \text{ mole Ca}$$

3. What is the mass in grams of
- $9.7 \times 10^{18}$
- molecules of
- $\text{SiO}_2$
- ?

$$9.7 \times 10^{18} \text{ molecules} \left( \frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ molecules}} \right) \left( \frac{60.1 \text{ g}}{1 \text{ mole } \text{SiO}_2} \right) = 0.00097 \text{ g} \text{ or } 9.7 \times 10^{-4} \text{ g}$$

## Percent Composition

4. What is the percent composition by mass of Boron in
- $\text{V}_2(\text{B}_4\text{O}_7)_5$
- ?

$$\frac{\text{mass of B in compound} \times 100}{\text{mass of compound}} = \frac{20(10.8 \text{ g}) \times 100}{2(50.9 \text{ g}) + 20(10.8 \text{ g}) + 35(16.0 \text{ g})} = 24.6 \%$$

## Empirical Formula

5. What is the empirical formula of
- $\text{H}_{15}\text{Br}_3\text{Cl}_{12}$
- ?
- $\text{H}_5\text{BrCl}_4$

6. Determine the empirical formula of a compound that contains 62.1% Carbon, 13.8% Hydrogen, and 24.1% nitrogen.

$$\text{C}_x\text{H}_y\text{N}_z \quad 62.1 \text{ g C} \left( \frac{1 \text{ mole}}{12.0 \text{ g}} \right) = \frac{5.18 \text{ mol}}{1.72} \quad 13.8 \text{ g H} \left( \frac{1 \text{ mole}}{1 \text{ g}} \right) = \frac{13.8 \text{ mol H}}{1.72}$$

$$24.1 \text{ g N} \left( \frac{1 \text{ mole}}{14.0 \text{ g}} \right) = \frac{1.72 \text{ mol N}}{1.72}$$

$$\boxed{\text{C}_3\text{H}_8\text{N}}$$

## Molecular Formula

7. Calculate the molecular formula of the compound whose molar mass is 60g that has an empirical formula of
- $\text{CH}_4\text{N}$
- .

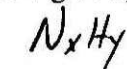
$$\text{CH}_4\text{N} = 1(12 \text{ g}) + 4(1 \text{ g}) + 1(14 \text{ g}) = 30 \text{ g}$$

$$\frac{\text{molecular mass}}{\text{empirical mass}} = \frac{60}{30} = 2 \quad \text{C}_{1 \times 2} \text{H}_{4 \times 2} \text{N}_{1 \times 2} = \boxed{\text{C}_2\text{H}_8\text{N}_2}$$

8. A sample of Hydrazine contains 28 g of nitrogen and 4 g of hydrogen. The molar mass of the molecule is 32g. What is the molecular formula of hydrazine?

$$28 \text{ g N} \left( \frac{1 \text{ mole}}{14 \text{ g}} \right) = \frac{2 \text{ mol N}}{2}$$

$$4 \text{ g H} \left( \frac{1 \text{ mole}}{1 \text{ g}} \right) = \frac{4 \text{ mol H}}{2}$$



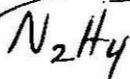
$$\text{N}_1\text{H}_2 = \text{empirical formula} = 16 \text{ g}$$

$$\frac{\text{molecular mass}}{\text{empirical mass}} = \frac{32 \text{ g}}{16} = 2 \quad \text{N}_{2 \times 1} \text{H}_{2 \times 2}$$

## Additional Questions

9. What is the relationship between the molecular formula and the empirical formula of a compound?

The empirical formula is the reduced form of the molecular formula  
 $\rightarrow$  lowest whole # ratio of atoms in a compound.



10. The percent compositions of the elements in a compound are 1.25% element 1, 19.86% element 2 and 78.89% element 3. If the compound is copper(I) hydroxide (
- $\text{CuOH}$
- ), identify elements 1, 2 and 3.

#1 Hydrogen #2 Oxygen #3 Copper.